Controller-Pilot Data Link Communications (CPDLC) for NASA Runway Incursion Prevention System

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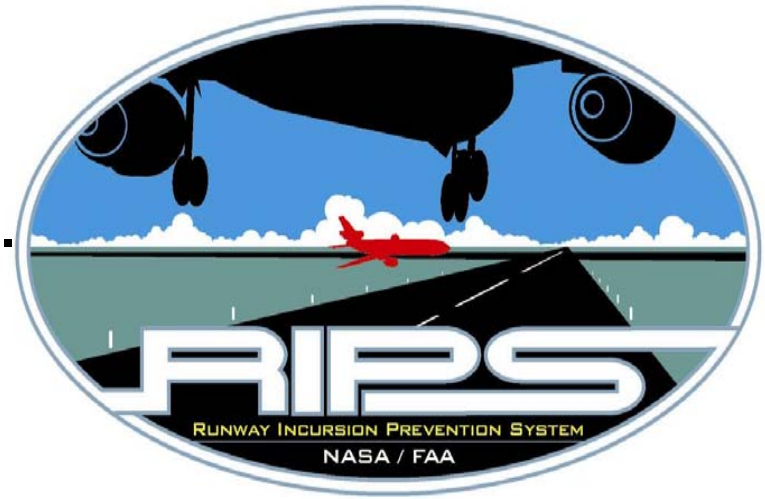
Overview

- Introduction
- NASA Runway Incursion Prevention System
- CPDLC
- C-CAST
- VDL-Mode2 Datalink
- Summary

Research performed by Ohio University and St. Cloud State University (MN) in conjunction with NASA-Langley Research Center

NASA Runway Incursion Prevention System

- Runway incursion alerts uplinked from ground and generated on aircraft.
- Surveillance technology included ASDE, ADS-B, multilateration, and loops

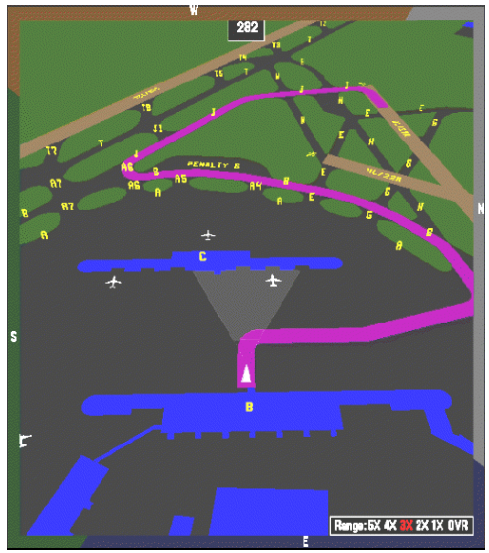


- Research systems installed on East side of DFW airport. East control tower used for base.
- NASA B757 used for airborne systems
- Data Collection and Demo at DFW – Fall 2000

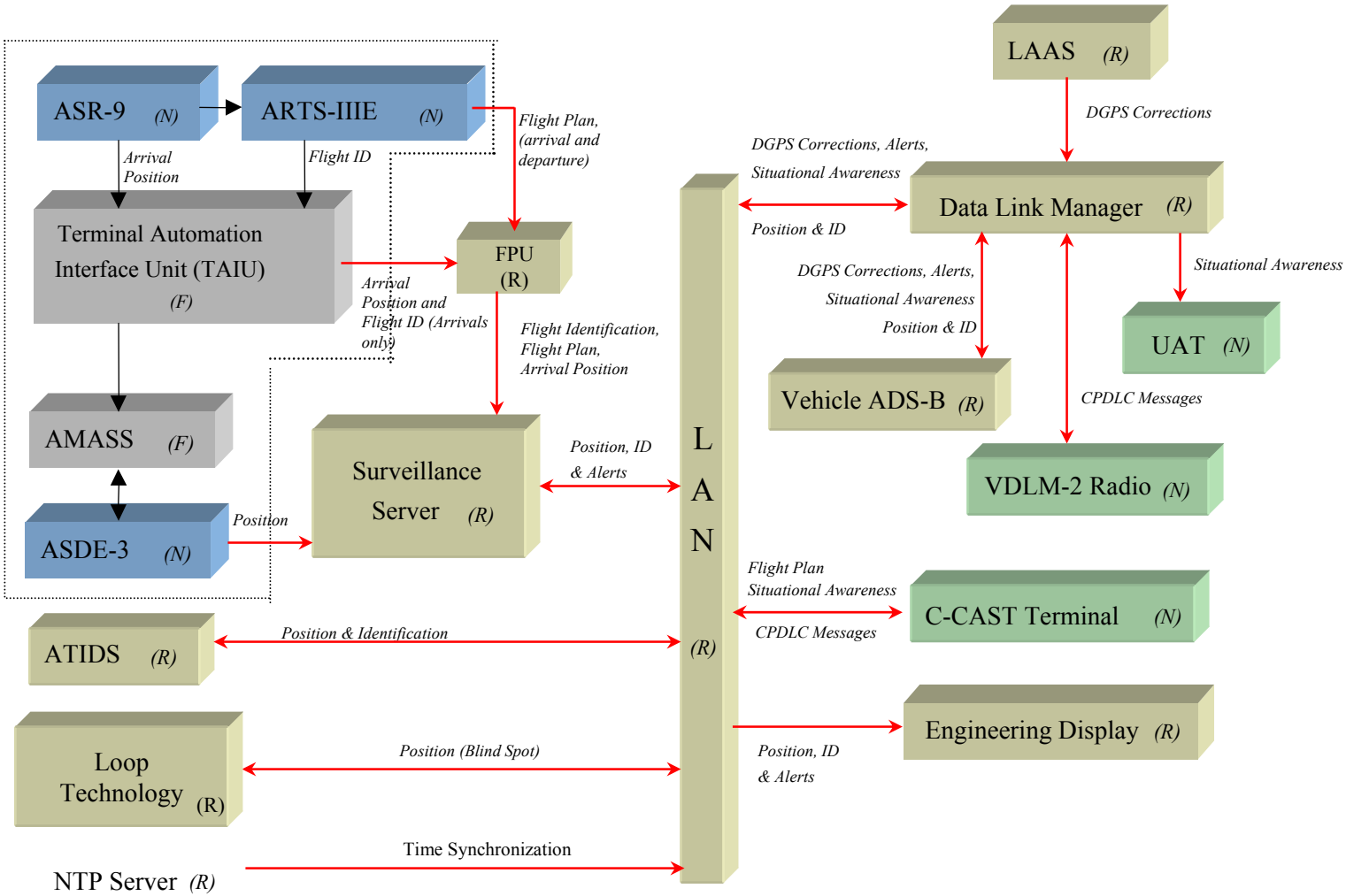
RIPS Concept

- Know exactly where you are
- Know exactly where other traffic is
- Know where you are to go.

HUD and HDD displays from B757



RIPS Ground Infrastructure



CPDLC Objectives

- To uplink ATC surface movement instructions to NASA B757 for Gate-to-Gate operations
- To provide terminal weather conditions to B757 for Land & Hold Short System (HSALT)
- To alert the controller to taxi deviations from assigned taxi path
- To alert the controller to Runway Incursion warnings generated by the B757 RIPS system
- To test the VDL-Mode 2 datalink technology

CPDLC

- RIPS CPDLC message set based on the ICAO ATN standard.
  - 1997 NASA LVLASO test at ATL based on RTCA DO-219 standard
- ICAO ATN standard does not include surface operation messages; new messages created using ICAO format
- Messages are variable length as a function of data fields
- Aircraft status messages automatically downlinked, e.g., TAXIWAY DEVIATION

CPDLC Uplink Message Set

ICAO Messages

0 UNABLE
1 STANDBY
2 REQUEST DEFERRED
3 ROGER
117 CONTACT [facility] [frequency]
120 MONITOR [facility] [frequency]
153 ALTIMETER [altimeter]

ATIS Messages (defined for experiment)

248 WIND [direction] AT [speed]
249 RUNWAY CONDITION [condition]
252 TEMPERATURE [temperaturec]

CPDLC Uplink Message Set

Surface Operation Messages (defined for experiment)

240 HOLD SHORT OF [position]
241 TAXI RUNWAY [runway] VIA [taxiroute]
242 TAXI RAMP [ramp] VIA [taxiroute]
243 CROSS [position] [WITHOUT DELAY]
244 CONTINUE TAXI
245 UNAVAILABLE TAXIWAYS [taxiways]
246 RUNWAY [runway] TAXI INTO POSITION AND HOLD
247 RUNWAY [runway] CLEARED FOR TAKEOFF
250 LAND AND HOLD SHORT OF [runway]
251 TAXI TO GATE [Gatenumber] VIA [taxiroute]
253 RUNWAY [runway] CLEARED TO LAND
254 TAXI TO SPOT [SpotNumber] VIA [taxiroute]

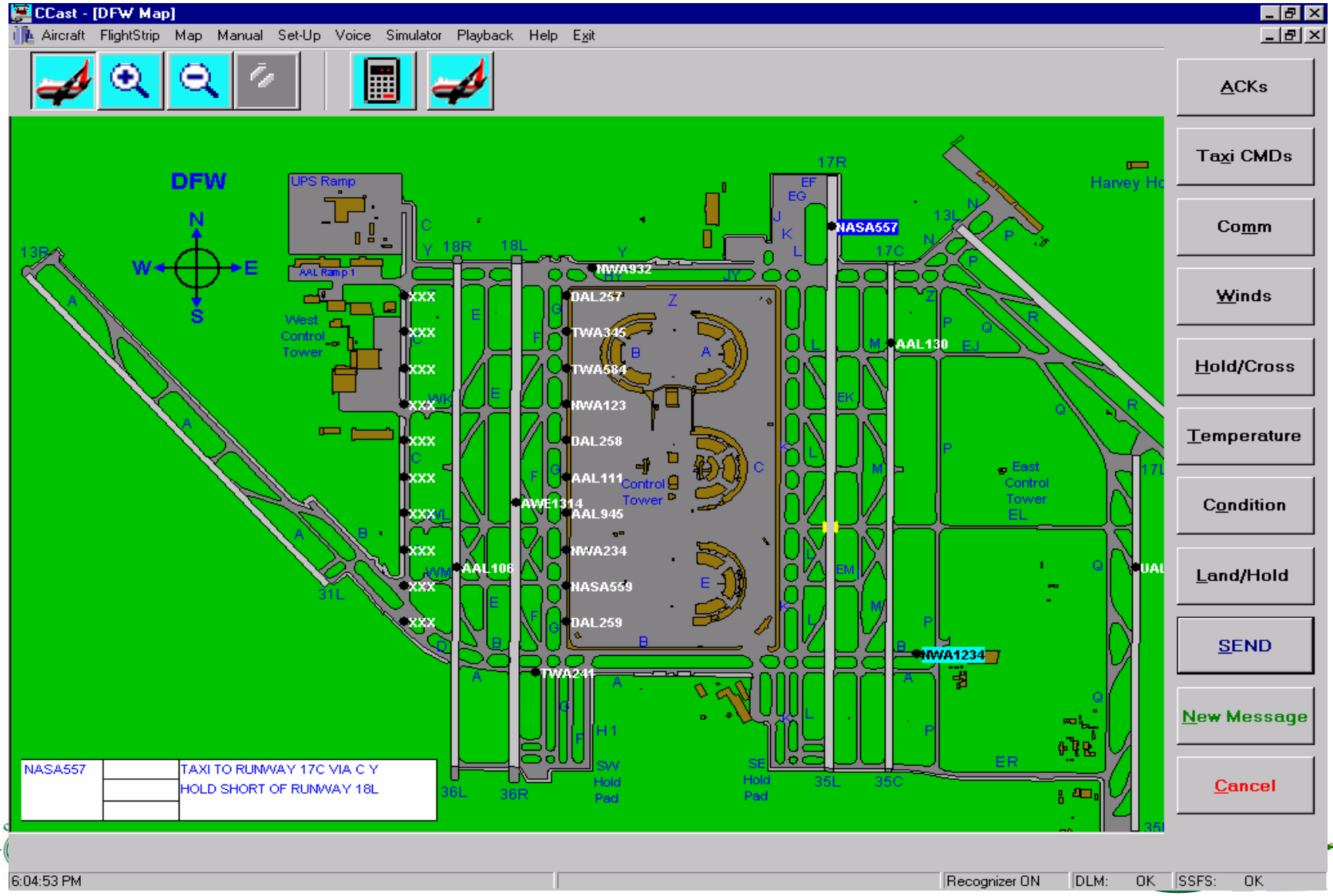
CPDLC Downlink Message Set

1	UNABLE
3	ROGER
102	LANDING REPORT
201	REQUEST TAXI CLEARANCE
202	TAXI DEVIATION
203	TURNED-OFF ON TAXIWAY [taxiway]
204	TAXI DEVIATION RESOLVED
205	RUNWAY INCURSION [source] [alarm type] [ID]
206	ASSIGNED GATE [gatenumber]

Controller's Communication and Situational Awareness Terminal (C-CAST)

- ATC display/terminal for generating and receiving CPDLC messages
- C-CAST handles up to 200 aircraft at a time using Electronic Flight Strips
- CPDLC uplink/downlink messages automatically displayed on flight strips.
  - Color denotes acknowledgement status
- Voice recognition used to generate CPDLC messages
  - Speaker Independent;No additional hardware (other than headset);No training; minimizes controller head's down time
- Touch screen LCD – minimize head's down time for controller
- TCP/IP protocol used between C-CAST and Datalink Manager

C-CAST Display



VDLM2

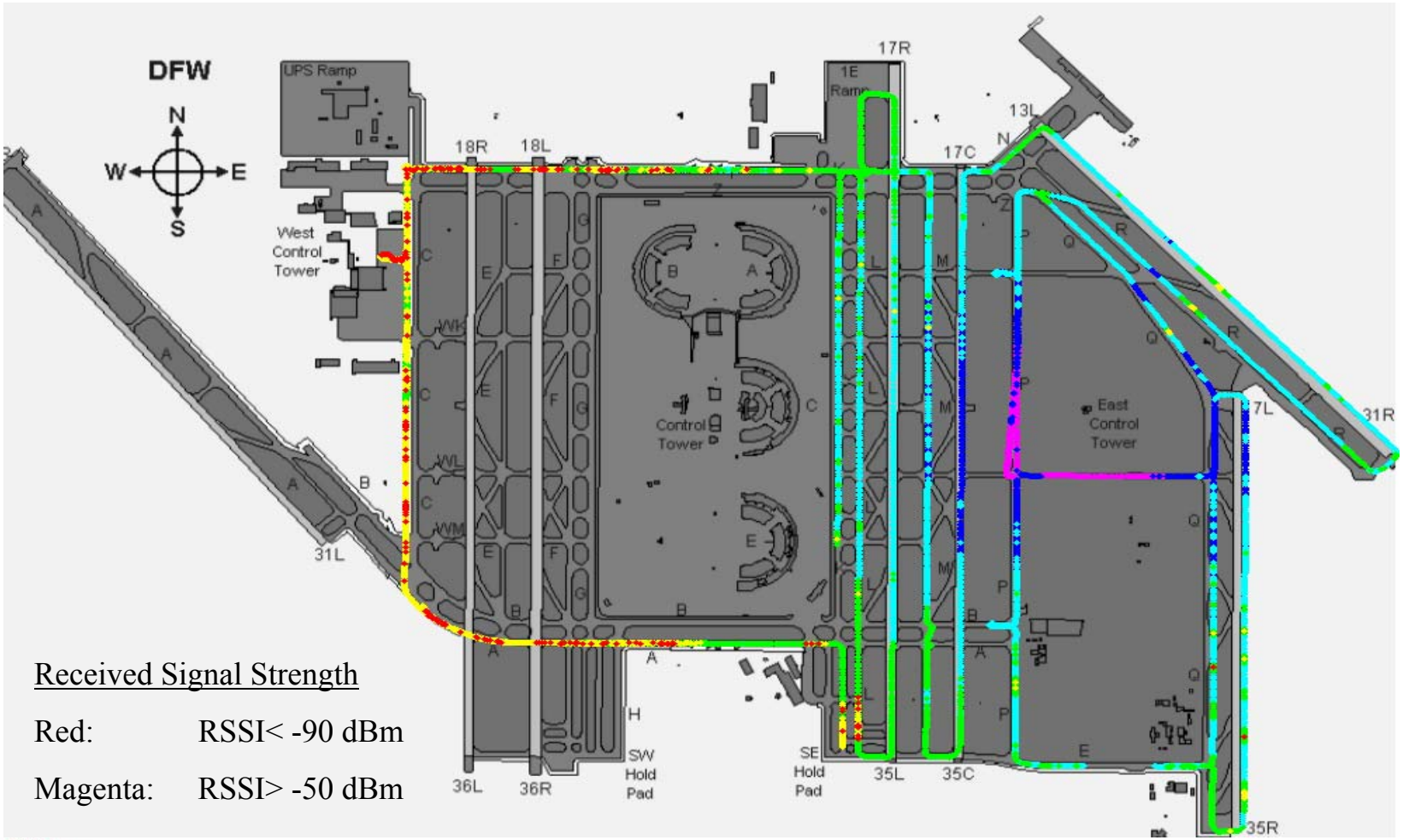
- The CPDLC datalink at DFW used a VDL-Mode 2 channel. In 1997, at ATL, a Mode-S channel was used
- VDLM2 System characteristics
  - 15 Watts transmit power
  - Vertically polarized signal
  - Omni-directional antenna
  - Used assigned frequency of 136.425 MHz at DFW
  - VDLM2 uses D8PSK for 31.5 kbps rate.
  - Carrier Sense Multiple Access (CSMA) protocol used for physical layer-media access
  - Aviation VHF Link Control (AVLC) protocol used for message format.

VDLM2 Equipment

Harris VDLM2 RX & TX
Same equipment used on B757

VDLM2 antenna mounted near East Control Tower

VDLM2 Signal Coverage



Summary

- Additional CPDLC messages need to be added to ICAO ATN for Surface Operations.
- RTCA SC194 is considering airport surface operations in ADL/CPDLC Build II.
- Additional work needed on voice recognition for terminal area controllers
- Transponders need to be turned on for surface operations to provide insight into Flight IDs
- Comm “tracking” is now possible in addition to surveillance tracking.
- Data analysis to be conducted during 2nd & 3rd quarters 2001.